(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 385,173. Patented June 26, 1888.

Fig. 1.

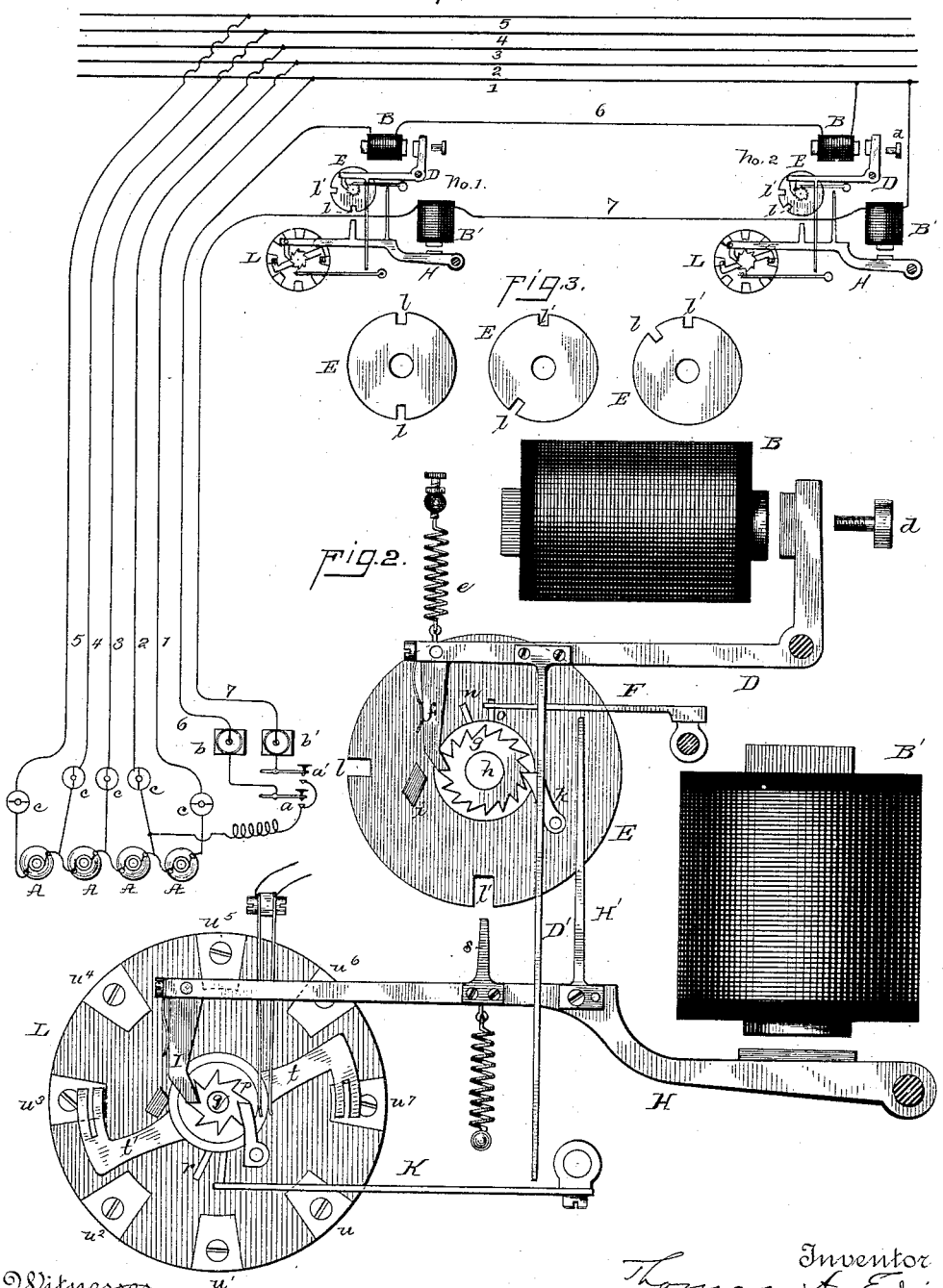

Fig. 3.

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

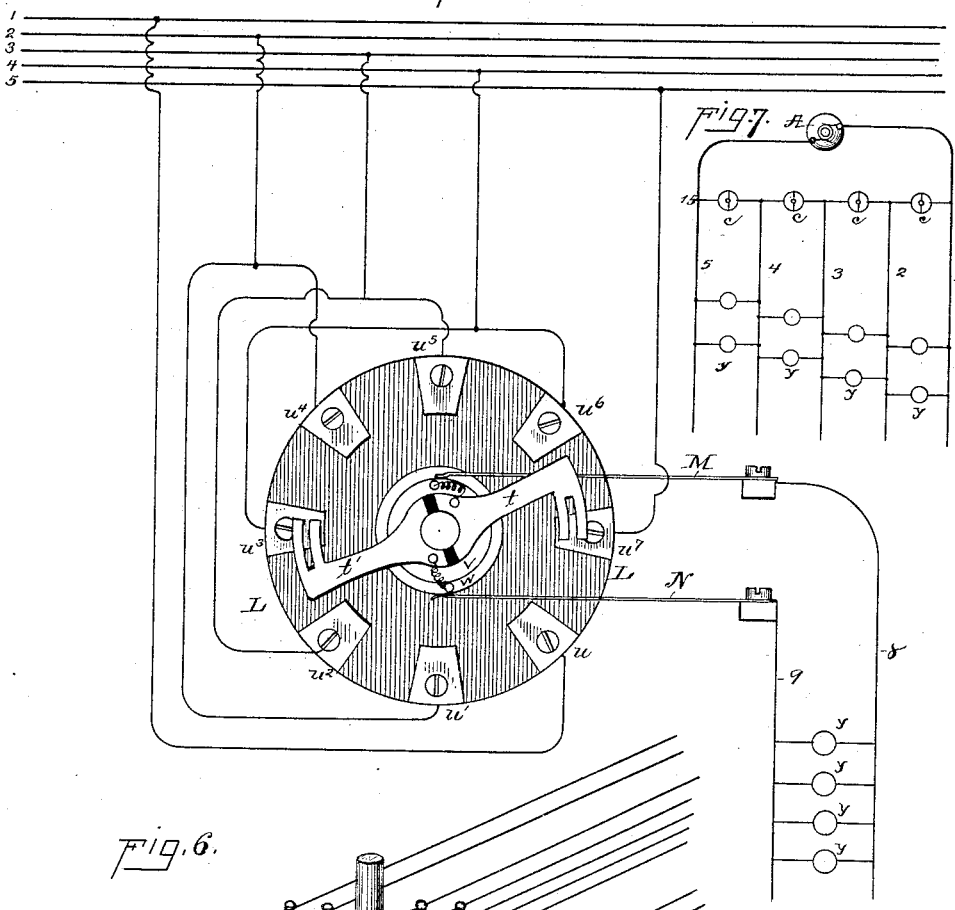


Fig. 7.

Fig. 6.

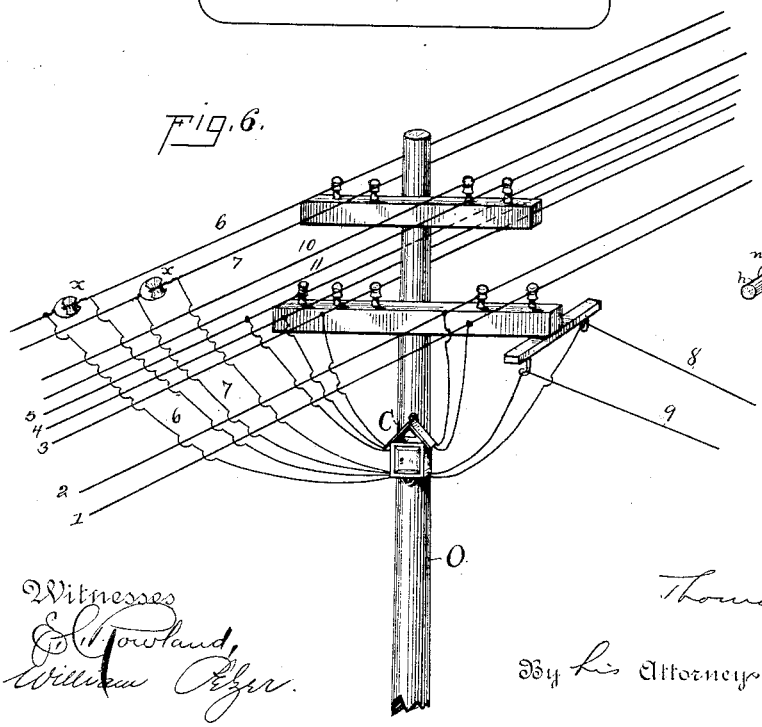
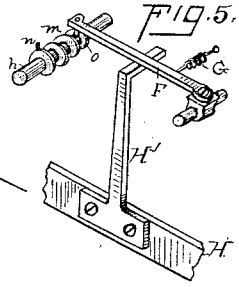


Fig. 5.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 385,173, dated June 26, 1888.

Application filed December 9, 1887. Serial No. 257,369. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 737,) of which the following is a specification.

My invention relates in part to compensating systems of electric lighting in which more than three wires are used, and more especially to the providing of apparatus in such systems controlled from the central station for shifting translating devices from one division of the system to another, so as to maintain the balance of the system. In my patent, No. 283,983, dated August 28, 1883, is set forth apparatus for this purpose for a simple three-wire system; but this apparatus cannot be employed in a more extended system except by multiplying the controlling circuits and apparatus.

One object, therefore, of my present invention is to provide simple and efficient devices for accomplishing the result above set forth in a system employing more than three main wires, whereby very small wires may be used for the compensating conductors, since they will never have to carry much current. I accomplish this, generally speaking, by connecting a suitable number of the house-circuits throughout the system to the main conductors through suitable circuit-controlling or switching devices, worked by electro-magnets placed in circuits from the station and of such character as when operated from the station to shift the connections—each of its particular house-circuit—progressively across from one division of the system to another division. I have devised a switching apparatus for this purpose, the use of which, however, is not confined to this purpose alone, but it may be used in any case where it is desired to control separately two or more of the circuits of a system from the central station. This switching apparatus forms a portion of my invention.

Generally speaking, the apparatus consists of an electrically-operated switch for each circuit to be controlled, and simultaneously electrically-controlled stops for these switches, such stops being situated or arranged differently with respect to the several switches, so that when such stops are moved simultaneously any particular switch can be released for action, while the other switches are kept from action by their stops.

My invention is illustrated in the accompanying drawings.

Figure 1 is a diagram of the system with the switching devices shown on a small scale; Fig. 2, a view of the switching apparatus at one point. Fig. 3 represents some of the simultaneously-operated stop-disks. Fig. 4 is a view of the switch with a diagram of the circuits; Fig. 5, a perspective view of the unison-stop device. Fig. 6 represents the preferred way of locating the circuits and switching apparatus, and Fig. 7 is a diagram of an arrangement which may be employed at the central station.

I have shown my invention in a five-wire system having four generators, A A, from which extend positive and negative conductors 1 5, and compensating conductors 2 3 4. Such a system will employ four lamps in series across these conductors.

6 and 7 are extra circuits of small wire, both extending from an outside conductor, 1, at some point in the district to the adjacent conductor, 2, at the station, whereby sufficient current is obtained for working the switching devices. At the station in each of these circuits is placed a key, *a* or *a'*, and an indicating-dial, *b* or *b'*, worked by a magnet. Ampère-indicators *c* are provided, as usual, in the conductors 1 to 5 at the station. Each switching apparatus includes two magnets, B and B'. All the magnets B are in series in circuit 6 and all the magnets B' in series in circuit 7.

All the switching mechanisms are alike, and I will describe one of them. Each is placed in a box, C, supported on a pole, or in any other convenient situation.

D is an armature-lever worked by magnet B, having a limiting-stop, *d*, retracted by a spring, *e*, and terminating in a pawl, *f*, for working a ratchet-wheel, *g*, on a shaft, *h*. The ratchet *g* has a greater number of teeth than there are switching-boxes in the whole system. I provide a stop, *i*, for the pawl *f*, and a stop-pawl, *k*, for preventing backward movement of the ratchet. On the shaft *h* is a disk, E, having two notches, *l l'*, in its periphery. The

notches l' are all at the same points on the periphery of all the disks in the system when the disks are at unison; but the notches l are then all at different points. The shaft h has a spiral groove or coarse screw-thread, m, at one end of which is the unison-pin n. The pivoted unison-arm F terminates in a pin, o, which rests in groove m, and a spring, G, tends to draw arm F away from pin n.

The magnet B′ has a pivoted spring-retracted armature-lever, H, terminating in a pawl, I, which works ratchet p on shaft q, and a similar unison mechanism to that above described is employed, K being the pivoted unison-arm, and r the unison stop-pin. The armature-lever H has an upwardly-projecting finger, s, close to the disk E, so that the arm is stopped from movement unless a notch, l or l', is presented to the finger s. A releasing-arm, D′, extends down from lever D close to unison-arm K, and a releasing-arm, H′, extends from lever H close to unison-arm F. Also upon the shaft q are two spring-arms, t t', which move across the eight stationary contact-plates u u' u^2, &c., secured in a circle upon the insulating-base L.

The connections from the five-wire circuit to the switch shown in Fig. 4 are as follows: The outside wires, 1 and 5, are respectively connected to the terminal plates u and u^7 of the series. The wires 2, 3, and 4 are each connected to two plates—wire 2 to u' and u^4, 3 to u^2 and u^5, and 4 to u^3 and u^6. There are also on the shaft two metal rings, v and w, on which bear, respectively, two springs, M N. From these springs extends the house-circuit 8 9, including lamps or other translating devices y y, which the particular switching-box controls. The rings v and w are connected, respectively, with the arms t and t'.

It will be seen that in the situation shown in Fig. 4 the house-circuit 8 9 is connected across the division 4 5 of the five-wire system, but that its connection can be progressively shifted across from one division to another by the movement of the arms t t'.

In Fig. 6 is shown a box, C, containing the switching mechanism above described, placed on a pole, O, of the pole-line of conductors. The box is looped in around insulators x in wires 6 and 7 in the usual manner, so that all the boxes are in series.

10 11 are the ordinary indicating or pressure wires of the system.

As above stated, I place these boxes at suitable intervals throughout the system. In ordinary practice one box for about every fifteen house-circuits will be sufficient. Ten lights controllable will maintain the balance for one hundred and fifty not controllable.

The operation of these devices is as follows: It is first usually required to bring all the switching-boxes into unison. To do this the operator works the key a, controlling the magnet B, so that the pawl f works the ratchet g around until the pin o, working in the spiral groove m, reaches the pin n, which prevents any further movement. He should continue working the key long enough to be sure that in all the boxes at least one complete revolution is given to the ratchets, so that he may know that the unison-arm has reached the unison-pin in every box. Then all the notches l' of all the disks E will be opposite the fingers s of levers H, but all the notches l will be in different positions relative to such fingers. He then taps the key a' and moves levers H and arms H′, which throws up arms F, and springs G pull arms F back to the other ends of grooves m, so that all the disks E are left at unison and free to be moved. To bring the switches into unison the key a' is now worked, so that magnets B′, armature-levers H, and pawls I work ratchets p around until all the arms K reach pins r. The fingers s enter the notches l' at each movement, such notches being provided for that purpose. Now by a single tap on key a arm D′ moves K, and K is thrown away from p, leaving the switches free to move, and also notches l' are all moved away from fingers s. The parts are now in position for switching. The operator at the station observes by the ampère-meters c c what is the condition of the different divisions of the system. If he observes a considerable change in any meter, he knows that certain customers have taken from or added to the number of lights in circuit to such an extent as to destroy the balance of the system. He therefore must change the connections of one or more circuits so as to restore the equality. Suppose the circuit of box No. 1 is connected to conductors 4 5 (as in Fig. 4) and it is desired to shift it over to 1 2. Key a is first worked—the operator noting the movements of dial b—until the notch l of step-disk E of box No. 1 is brought opposite the finger s of that box; but in all the other boxes no notches will be presented to the fingers s. Now by working key a' only box No. 1 will be affected, since in the other boxes the motion of arms H will be stopped by disks E. In box No. 1 the first movement of the key will cause ratchet p to turn and move arms t and t' to plates u^2 and u^6, which will put the house-circuit across conductors 3 and 4. The next impulse moves the arms to u' and u^5, which puts the circuit across 2 and 3, and the next impulse moves the arms to u and u^4 and connects the house-circuit between 1 and 2. The apparatus thus progressively shifts the connections of the house-circuit across the system to any one of the divisions to which it is desired to connect it. Another tap of the key will bring the arms to u^3 and u^7 again and connect the house-circuit once more to 4 5, but with the circuit reversed. There is no objection to this in systems where no house-meters, or meters other than electrolytic meters, are employed; but where electrolytic meters are in circuit it will not do to reverse the connections permanently, and the operator therefore, in order to shift back to 4 5, must work his key rapidly, and work the arms entirely around the disk

back to the original point without allowing the arms to rest on the plate. There will thus be only a momentary reversal of the current, which will make no practical difference.

In Fig. 1 box No. 1 is shown in position to have its circuit shifted, and box No. 2 is not. If No. 2 is to be changed, the operator—still watching his indicating-dial *b*—works the key *a* until he brings the notch *l* of disk E of that box around opposite the finger *s*, when the switch may be worked by the key *a'* to change the connection made from this box to any desired division of the system.

It is evident that each set of magnets may be placed in multiple arc across a circuit, instead of in series; or I may place both sets of magnets in multiple arc or in series in the same circuit and provide differently-polarized armatures for said magnets, so as to work one set by a current of one polarity and the other by current of opposite polarity, a reverser being provided at the station.

Instead of the keys at the station, I may use a revolving circuit making and breaking transmitter, in which case the indicating-dials might be dispensed with.

Since by my invention I am enabled to so maintain the balance of the system that little or no current will flow on the intermediate or compensating wires at any time, it is not always essential to have as many generators as there are divisions of the system; but a single generator or other undivided source of supply may be employed, as in Fig. 7, with a connection, 15, across the circuit near its terminals, to which connection all the compensating wires are brought, such connections being through electrical indicators—one for each division. The system is thus divided, and the indicators show when it is slightly out of balance, and such irregularities are corrected by the switching mechanisms in the manner already explained. In this figure, A may represent a single generator, or two or more generators, arranged in series and giving the required electro-motive force.

What I claim is—

1. In a system of electrical distribution, the combination of two or more electrically-operated switches, two or more simultaneously electrically-controlled stops—one for each switch—such stops being situated or arranged differently relative to their respective switches, whereby any particular switch can be released for action while the others are held from action by the stops, and a circuit controlled by each switch, substantially as set forth.

2. In a system of electrical distribution, the combination of a main circuit extending from a central station, two or more branch circuits supplied therefrom, a switch for each of said branch circuits, a magnet for operating each switch, a circuit from the station including all said magnets, a circuit-breaker in said circuit at the station, a movable stop for each switch, such stops being situated or arranged differently relative to their respective switches, a magnet controlling the position of each stop, a circuit from the station including all said stop-magnets, and a circuit-breaker in said circuit at the station, substantially as set forth.

3. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, house-circuits, each connected in multiple arc with a pair of said conductors, and switches for certain of said house-circuits, controlled from the central station, for shifting the connections thereof progressively from one pair of conductors to the other pairs, substantially as set forth.

4. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, a switch having a suitable number of contact-plates, connections from pairs of said plates to the main conductors, two arms bearing on said plates and movable relative thereto, and a house circuit connected with said arms, whereby the movement of said arms shifts the connections of said house-circuit from one pair of main conductors to another, substantially as set forth.

5. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, house-circuits, each connected in multiple arc with a pair of said conductors, switches for certain of said house-circuits, for shifting the connections thereof progressively from one pair of conductors to the other pairs, and magnets controlled from the central station for operating said switches, substantially as set forth.

6. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, a switch having a suitable number of contact-plates, connections from pairs of said plates to the main conductors, two arms bearing on said plates and movable relative thereto, a house-circuit connected with said arms, whereby the movement of said arms shifts the connections of said house-circuit from one pair of main conductors to another, and a magnet controlled from the central station for operating said switch, substantially as set forth.

7. In a system of electrical distribution, the combination of a main circuit extending from a central station, two or more branch circuits supplied therefrom, a switch for each of said branch circuits, a magnet and an armature-lever for operating each switch, a circuit from the station including all said magnets, a circuit-breaker in said circuit at the station, a rotating stop-disk for limiting the movement of each of said armature-levers, said disks each having a notch and such notches being all located at different points on the disks' peripheries, a magnet and suitable gearing controlled thereby for revolving each disk, a circuit from the station including all said magnets, and a circuit-breaker in said circuit at the station, substantially as set forth.

8. In a compensating system of electrical distribution, the combination, with the main and compensating conductors forming the

main circuit, of branch circuits connected therewith and unisoned switching mechanism controlled from the central station, for independently controlling said branch circuits, substantially as set forth.

9. In a system of electrical distribution, the combination of the switches revolved by electro-magnets controlled from the station, the stop-disks for said switches revolved by other magnets controlled from the station, unison-stops for the switches, unison-stops for the disks, releasing devices for the stop-disk unisons operated by the switch-magnets, and releasing devices for the switch-unisons operated by the stop-disk magnets, substantially as set forth.

10. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, switches, each having a suitable number of contact-plates, connections from pairs of contact-plates in each switch to the main conductors, two arms bearing on the plates of each switch and movable relative thereto, a house-circuit connected with the arms of each switch, a magnet for operating each switch, a circuit from the station including all said magnets, a circuit-breaker in said circuit at the station, a movable stop for each switch, such stops being situated or arranged differently relative to their respective switches, a magnet controlling the position of each stop, a circuit from the station including all said stop-magnets, and a circuit-breaker in said circuit at the station, substantially as set forth.

This specification signed and witnessed this 5th day of November, 1887.

THOS. A. EDISON.

Witnesses:
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